

wall and the inner surface of the susceptor side wall, including at the annular seam between the top of the susceptor and the crucible.

At high operating temperatures in the crystal puller, such as 1500 °C, graphite reacts with quartz (i.e., fused silica) as follows:



The first reaction [1] is a solid state reaction resulting in gaseous SiO as a product, which then reacts with the graphite in accordance with the second reaction [2] to form SiC. The SiC is formed by conversion of graphite and therefore introduces stresses inside the susceptor. The stresses developed in the susceptor may result in distortion of the susceptor or otherwise render the susceptor prone to cracking or failing. The conversion of graphite also tends to substantially widen the gaps in the seams between the susceptor pieces and between the crucible side wall and the susceptor side wall and thereby promote the reaction. Thus, the formation of SiC in accordance with the chemical reaction occurring between the quartz crucible, the graphite susceptor and the SiO gas negatively effects the useful lifetime of the susceptor.

Claim 1

Claim 1 recites a crystal puller for producing a monocrystalline ingot comprising, in pertinent part:

- a) a susceptor having a bottom and a side wall;
- b) a crucible for holding molten source material;

- c) a heater;
- d) a pulling mechanism positioned above the crucible for pulling the ingot from the molten source material held by the crucible; and
- e) a sealing member adapted for close contact relationship with the crucible side wall and the susceptor side wall to generally seal between the crucible and the susceptor any gaseous product resulting from a reaction of the crucible with the susceptor against escape from between the crucible and the susceptor thereby retarding the reaction of the crucible with the susceptor.

Claim 1 is submitted as patentable in that SU 1,680,810 (Kalugin) does not show **a sealing member adapted for close contact relationship with the crucible side wall and the susceptor side wall to generally seal between the crucible and the susceptor any gaseous product resulting from a reaction of the crucible with the susceptor against escape from between the crucible and the susceptor thereby retarding the reaction of the crucible with the susceptor.**

* Referring to the enclosed translation, Kalugin discloses a crystal-growing chamber comprising an upper section 1 and a lower section 2. A sealing device in the form of an annular collar 12 is provided between the upper and lower sections **of the chamber**. The lower section includes a crucible 8 received within a base 9. Fig. 2 of Kalugin shows an unnumbered "ring" resting atop upper ends of the crucible and the base. There is no disclosure in Kalugin regarding the construction or function of this ring beyond the drawing.

The Examiner asserts that claim 1 is anticipated by Kalugin because Kalugin shows a "ring is placed over the tops of the susceptor and crucible." However, claim 1 requires "**a sealing member adapted for close contact relationship with the crucible side wall and the susceptor side wall to generally seal between the crucible and the susceptor any gaseous product.**" Kalugin does not describe a sealing member adapted for close contact relationship or which generally seals gaseous product between the crucible and the susceptor. Rather, Kalugin is directed to a device for sealing the gap between its upper and lower sections so as to seal **the growing chamber**, and to making the puller easier to service and quicker to use. Kalugin's written specification contains very little information about its base and crucible, and no description of the "ring" on top of the base and crucible. In particular, there is no disclosure or suggestion of a close contact relation which generally seals between the crucible and susceptor. Accordingly, Kalugin does not anticipate the claimed invention.

Additionally, Kalugin does not render applicants' invention obvious because it does not show all of the features of the invention and contains no suggestion for modification because it does not discuss or recognize the problem caused by the reaction between applicants' crucible and susceptor. Since Kalugin does not reveal what its base and crucible are made of, it is not clear whether such a reaction even occurs. The base may be made of tungsten or other materials which would not cause the reaction. Moreover, because Kalugin does not state that the base has multiple pieces or seams, its unclear whether Kalugin

would encounter the same type of problems as described above with respect to seams in most conventional susceptors.

Claim 1 is, therefore, submitted as patentable over Kalugin. Applicants have also reviewed the other art of record and determined that claim 1 is patentable over such art. Claims 1-8 depend directly or indirectly from claim 1 and are submitted as patentable for the same reasons as claim 1.

Claim 3 recites that a seam between the crucible and susceptor is defined by the crucible side wall and **an upper rim of the susceptor side wall**. (See Fig. 4). Moreover, the sealing member seats on the upper rim of the susceptor side wall in close contact relationship with the crucible side wall substantially about the entire circumference of the crucible side wall generally over said seam. These features are not shown by Kalugin, and claim 3 is therefore submitted as patentable for this additional reason.

Claim 5 states that the sealing member is constructed of graphite, and claim 7 states the susceptor is constructed of at least two pieces. The claims are rejected as obvious over Kalugin. Applicants respectfully traverse the rejection in that Kalugin does not describe its "ring", much less the material of construction, nor does it describe or suggest that the "base" be made of at least two pieces.

Claim 9

Claim 9 recites a susceptor assembly comprising, among other things, a sealing member adapted for close contact relationship with the crucible side wall and the susceptor side wall to generally seal between the crucible and the susceptor any gaseous

product resulting from a reaction of the crucible with the susceptor against escape from between the crucible and the susceptor thereby retarding the reaction of the crucible with the susceptor. To the extent claim 9 corresponds to claim 1, it is submitted as patentable for the same reasons as claim 1. Claims 10-16 depend from claim 9 and are submitted as patentable for the same reasons as claim 9. Claims 10, 13 and 15 correspond to claim 3, 5 and 7, respectfully, and are submitted as patentable for the same additional reasons.

Claim 17

Claim 17 is directed to a method for growing monocrystalline ingots comprising, in pertinent part, heating the susceptor and crucible to a temperature sufficient to melt the semiconductor source material held by the crucible, said heating **causing the crucible to react with the susceptor therebetween to produce a gaseous product**; and generally **sealing said gaseous product between the susceptor and crucible** to increase the concentration of said gaseous product therebetween, thereby inhibiting further reaction of the crucible with the susceptor.

As discussed above, Kalugin does not state or suggest that there is a reaction between its crucible and base. Further, Kalugin does not state whether the ring over the crucible and base is constructed to seal gaseous product between the crucible and base. Accordingly, applicants submit claim 17, as well as dependent claims 18-19, to be patentable over Kalugin. Claim 19 corresponds to claim 3 and is submitted as patentable for the same additional reason.